

Amendments to the Specification

Please enter the following amendments, which refer to the published U.S. application:

Please amend the title as follows:

METHOD ~~[[AND APPARATUS]]~~ FOR COLD JOINING
~~[[FLANGES AND]]~~ A COUPLING~~[[S]]~~ ELEMENT~~[[S]]~~ TO A PIPE~~[[S]]~~

At page 1, before paragraph [0001], insert the following title:

BACKGROUND OF THE INVENTION

At page 1, paragraph [0001]:

The invention relates to a ~~system and method for joining flanges or other coupling elements to pipes and a tool for performing the method and a tool for joining a coupling element, for example, a joining flange means, to a pipe, said coupling element surrounding the pipe and having grooves facing the pipe and intended to receive a corresponding plurality of beads provided on the pipe and a coupling element connectable to a pipe, said coupling element configured to surround the pipe and having grooves to face the pipe and to receive a corresponding plurality of beads provided on the pipe.~~

At page 1, before paragraph [0002], insert the following title:

FIELD OF THE INVENTION

At page 1, before paragraph [0003], insert the following title:

DESCRIPTION OF RELATED ART

At page 1, before paragraph [0005], insert the following title:

BRIEF SUMMARY OF THE INVENTION

At page 1, paragraph [0005]:

The object of the invention is to provide a system for joining flanges or other coupling elements to pipes where the a tool is only operated radially so that a fixing of the pipe is not necessary. Furthermore, it is an object to obtain a tool which even in connection with small pipe dimensions has enough force to deform beads in relatively thick pipe walls. It is also an object that the tool should function so that inward tapering of the pipe end, which has been found to be a problem in connection with the radial pressing of beads is avoided.

At page 1, before paragraph [0006], insert the following:

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings,

Fig. 1a is a side view of a pipe and a coupling.

Fig. 1b is a section A-A of Fig. 1a without beads created on the pipe.

Fig. 1c is an enlargement of encircled region B in Fig. 1b.

Fig. 1d is a modified section A-A of Fig. 1a with beads created on the pipe.

Fig. 2a shows a modified coupling element with inserted pipe.

Fig. 2b shows a section A-A of Fig. 2a.

Fig. 3a shows a side view of a pipe, a coupling element and an inserted tool in a first operational stage prior to coupling operation.

Fig. 3b shows a section A-A through the assembly of pipe, coupling element and tool part of Fig. 3a.

Fig. 3c shows a side view of the assembly shown in Fig. 3a in a second operational stage of the tool after coupling has been made thereby between the pipe and the coupling element.

Fig. 3d shows a section B-B through the assembly of Fig. 3c.

Fig. 4a is a side view of the tool, and Fig. 4b is a section A-A of Fig. 4a.

Fig. 5a is a perspective view of the tool from a first angle, and Fig. 5b is a perspective view of the tool from a second angle.

Fig. 6 is a side view of the tool.

Fig. 7a is a side view of a modified tool with a hydraulic force amplifier, and Fig. 7b is a functional expansion acting element of the tool.

Fig. 8a is a side view of a pipe with a modified coupling element structure, and Fig. 8b is a section A-A through the embodiment of Fig. 8a.

Fig. 9 illustrates final adjustments of an established coupling.

DETAILED DESCRIPTION OF THE INVENTION

The invention is now to be described in further detail with reference to the attached drawing figures.

At page 1, paragraph [0006]:

~~FIG. 1 shows a pipe and coupling elements before the beads (5, 6) are pressed in. FIG. 2 shows the same after the beads have been pressed into the coupling element. FIG. 3 shows a collar pressed into place for a loose flange. FIG. 10 shows a flange having spherical movability.~~

Figs. 1a-1c show a pipe 1 and a coupling element 2 before beads 5, 6 are created. Fig. 1d shows the same after the beads 5, 6 created on the pipe 1 have been pressed into recesses 3, 4, respectively in the coupling element 2.

Figs. 2a and 2b show a coupling element 2' fitted onto a pipe 1 and with beads 5, 6 pressed into place into recesses in the coupling element 2", the coupling element having a flange 2'" for attachment to another coupling element (not shown):

Fig. 8 shows a coupling element structure 30 with flanges 30', 30" being tiltable relative to the structure 30 by movability over the partially spherical surface of the coupling element 30.

The principle of the tool is shown on Figs. 4a and 4b, whilst different applications of a cone shaped member 20, used as a mechanical force amplifier, fitted into the tool, to cause expansion of tool diameter to create beads in the pipe wall are shown in Figs. 4-6.

At page 1, paragraph [0008]:

During the development of the apparatus according to the invention, which comprises both ~~the an~~ interior configuration of the external coupling element 2; 2' and the tool 10 which forms the beads 5, 6, it was quickly discovered that the most critical parameter for optimal attachment resides in the configuration of the parts 11, 11 of the tool that presses the beads 5, 6 out from the pipe and also ~~the a~~ part 14 of the tool that is to prevent the end of the pipe 1 from tapering inwards during the pressing operation.

At page 1, paragraph [0009]:

~~Figs. 1 and 2~~ Figs. 1a-1d show that ~~the an~~ outermost portion ~~(a)~~ 2' of the coupling element 2 against which ~~the~~ pipe end ~~(b)~~ 1' rests is flared outwards. This is to allow the tool to give the pipe end ~~(b)~~ 1' an overbending outwards, which is necessary because the pipe end as mentioned, will otherwise tend tends to taper inwards. Thus, the pipe 1 is will appear almost straight after the beads ~~[(5, 6)]~~ 5, 6 have been pressed, as can be seen in the ~~enlarged section shown~~ in ~~FIG. 2~~ Fig. 1d.

At page 1, paragraph [0010]:

The same basic interior configuration of the coupling elements will apply to a coupling element or collar intended for loose flanges, movable flanges as shown in ~~FIG. 3~~ Fig. 8, ~~spherically movable flanges as shown in FIG. 4~~ and other types which may be suitable for ~~the a~~ same fastening method.

At page 1, paragraph [0011]:

It should be mentioned that the cylindrical part ~~(e)~~ of the coupling element 2; 2' as shown in ~~FIG. 3~~ on Figs. 1, 2 and 3 may advantageously be quite thin-walled. To a certain extent, the wall will then be resilient and yield a little during the pressing operation, and this will then mean that afterwards it is under inward tension and thus provides further pressure in the connection where the pipe 1 is in tension outwards.

At page 1, paragraph [0012]:

~~Tests~~ Laboratory tests carried out ~~in the laboratory~~ show that a mechanically good seal is obtained between the grooves ~~[(3,4)]~~ 3,4 and the beads ~~[(5,6)]~~ 5,6. Nevertheless, it may be appropriate to insert a sealing material in one or more of the grooves.

At page 1, paragraph [0013]:

According to Figs. 4a and 4b ~~FIG. 5~~, the principle of the tool is based on a plurality of segments ~~[(10)]~~ 10 having circular segment ridges ~~[(11)]~~ 11 intended for being pressed out towards the inside of the pipe wall and thus forming the beads 5, 6 first. Towards the end of the pressing operation, the cylindrical segment parts ~~[(13)]~~ 13 of each of the segments forming a cylindrical assembly of segments is pressed against the inside of the pipe at ~~in~~ the portions located sideways relative to ~~on the sides of~~ the beads 5, 6 to prevent said portions ~~them~~ from buckling inwards. This process is shown ~~in FIG. 4a and FIG. 4b~~ on Figs. 3a-3d as well as on Fig. 9 ~~[[in FIG. 11]]~~. Figs. 3a and 3b show ~~[[FIG. 4a shows]]~~ the pipe ~~[(1)]~~ 1 and the coupling ~~[(2)]~~ 2 before the pressing operation, and Fig. 9 ~~[[FIG. 11]]~~ is an enlarged view of ~~[[the]]~~ an intermediate stage during the pressing where the aforementioned buckled-in areas 1" ~~[(b)]~~ of the pipe sideways relative to ~~[[on the side of]]~~ the beads 5, 6 can be seen. In ~~[[FIG. 4b]]~~ Figs. 3c and 3d it is seen that the cylindrical parts 13 ~~[[portions]]~~ of the segments 10 have pressed the buckled-in areas 1" back towards the coupling element 2 so that they lie almost flush with the inside wall of the pipe and its diameter ~~[[of the pipe]]~~. This after-pressing gives a powerful radial tensioning effect in the pipe which increases the contact pressure between pipe 1 and coupling element 2, ~~[[in]]~~ the sealing points between beads 5, 6 and grooves 3, 4, and prevents retraction of the pipe 1 as mentioned above when referring to plain ridges as previously described in, for example, DE 3144385. A projection 14 is located ~~[[1]]~~ innermost on the segments 10, i.e. close to a tool element flange 21, ~~[[there is provided a]]~~ said projection 14 ~~[(14) which presses]]~~ intended to cause pressure against the end 1" of the pipe, as indicated also on Fig. 9. In a corresponding portion of the coupling element 2 there is a recess 15 ~~[(a)]~~ which may be made in the form of a bevel edge or a cut-out. This cut-out 15 can, for some uses, be partially filled with sealing material, or it may have an

O-ring fitted therein. This special design of the tool and the coupling element has been found to be necessary in order to prevent the pipe from tapering or buckling inwards as previously mentioned.

At page 2, paragraph [0014]:

The segments ~~[[10]]~~ 10 and especially the ridges ~~[[11]]~~ 11 are subjected to extremely large stresses during the pressing operation and are therefore made of hardened steel. Consequently large radial forces are also required to operate the segments 10. As an example thereof, the pressing of a connection between a coupling element 2 and of a steel pipe 1 with an outer diameter of 76 mm and a wall thickness of 3.2 mm as shown ~~in FIGS. 2 and 3, with~~ on Figs. 1d, 2a and 2b by using eight segments 10 would require a radial force per segment of about 200 kN, in total a required force of about 1600 kN. These are huge forces within a very narrow space, and the tool according to the invention therefore uses a power actuator located outside the pipe 1 combined with a force amplifier 20 inside the pipe 1.

At page 2, paragraph [0015]:

~~[[FIG. 6]]~~ Fig. 5a shows the tool with segments 10 and with a circular cone ~~[[20]]~~ 20 acting as force amplifier, ~~[[FIG. 7]]~~ Fig. 5b shows the tool with the cone 20 drawn in and the segments 10 in expanded position. ~~[[FIG. 8]]~~ Fig. 6 shows the same tool with a polygonal pyramid 20' acting as force amplifier.

At page 2, paragraph [0016]:

~~[[FIG. 9 shows]]~~ Figs. 7a and 7b show a tool with hydraulically operated segments 22. ~~A where a~~ segment ~~[[22]]~~ 22 is shown separately and it can be seen that the segment 22 is fastened to a piston ~~[[27]]~~ 27 which can move in a corresponding cylinder 28 in ~~[[the]]~~ a housing 24 ~~[[24]]~~ which is filled with oil. The segments 22 have circle sector ridges 23 to create beads. ~~[[In the]]~~ The illustrated tool ~~[[, there will thus be]]~~ has a total of eight pistons 27 and eight cylinders 28. When ~~[[the]]~~ a rod ~~[[25]]~~ 25 is pressed into the housing, the oil in the housing 24 will press the pistons ~~[[27]]~~ 27 outwards. The greater the diameter of the piston 27 in relation to the diameter of the rod 25, the greater the force amplification. Reference numeral 21 denotes a tool attachment flange, the flange having a plurality of attachment holes 26.

At page 2, paragraph [0017]:

A cold joining of the coupling element 2 to the pipe 1 in this manner ~~of this kind means~~, unlike, for example, welding, that the material of the coupling is not given a modified surface structure. Therefore, the invention is suitable for couplings as shown in ~~[[FIG. 10]]~~ Figs. 8a and 8b where a ~~spherical~~ coupling element ~~[[30]]~~ 30 has an outer surface being part of a spherical surface, the coupling element 30 to be ~~[[is]]~~ fastened to the pipe 1 and where a two-part flange ~~[[31, 32]]~~ has parts 30', 30" which can be joined to each other by screw action attachment, ~~[[is screwed together,]]~~ the two parts 30', 30" located ~~facing one another~~ on each side of the coupling element and facing one another. The flange with its flange parts 30', 30" will then be capable of being mounted at an ~~[[a variable]]~~ angle which can be variably set relative to the pipe. The flange with its parts 30', 30" ~~[[#]]~~ will either be freely movable, even after screwing the flange parts 30', 30" together, or will be such that it is locked to the coupling element ~~[[30]]~~ 30 when the flange 30', 30" is tightened to another flange (not shown).